Fusion in the energy system

Grohnheit, Poul Erik

Publication date:
2009

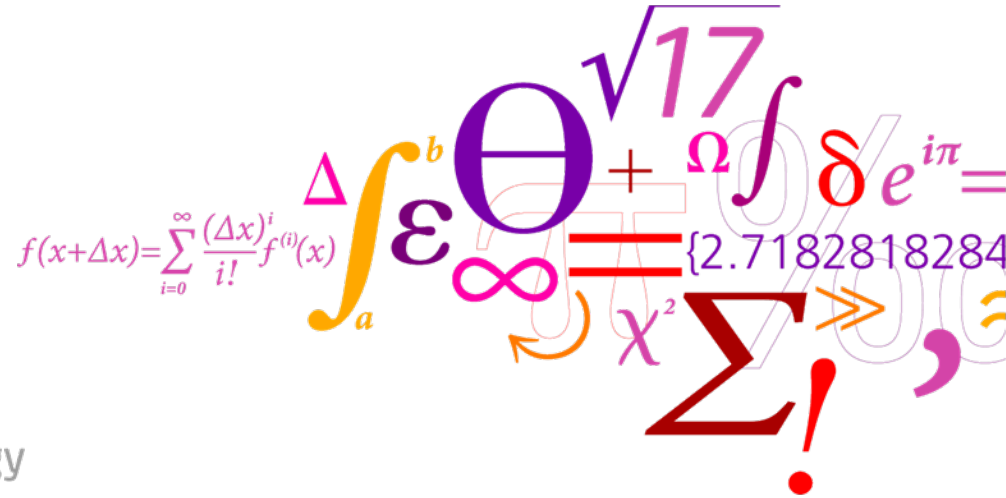
Fusion in the energy system

Poul Erik Grohnheit

Systems Analysis Division, Risø DTU

pogr@risoe.dtu.dk

European Environment Agency,
Copenhagen 10 November 2009

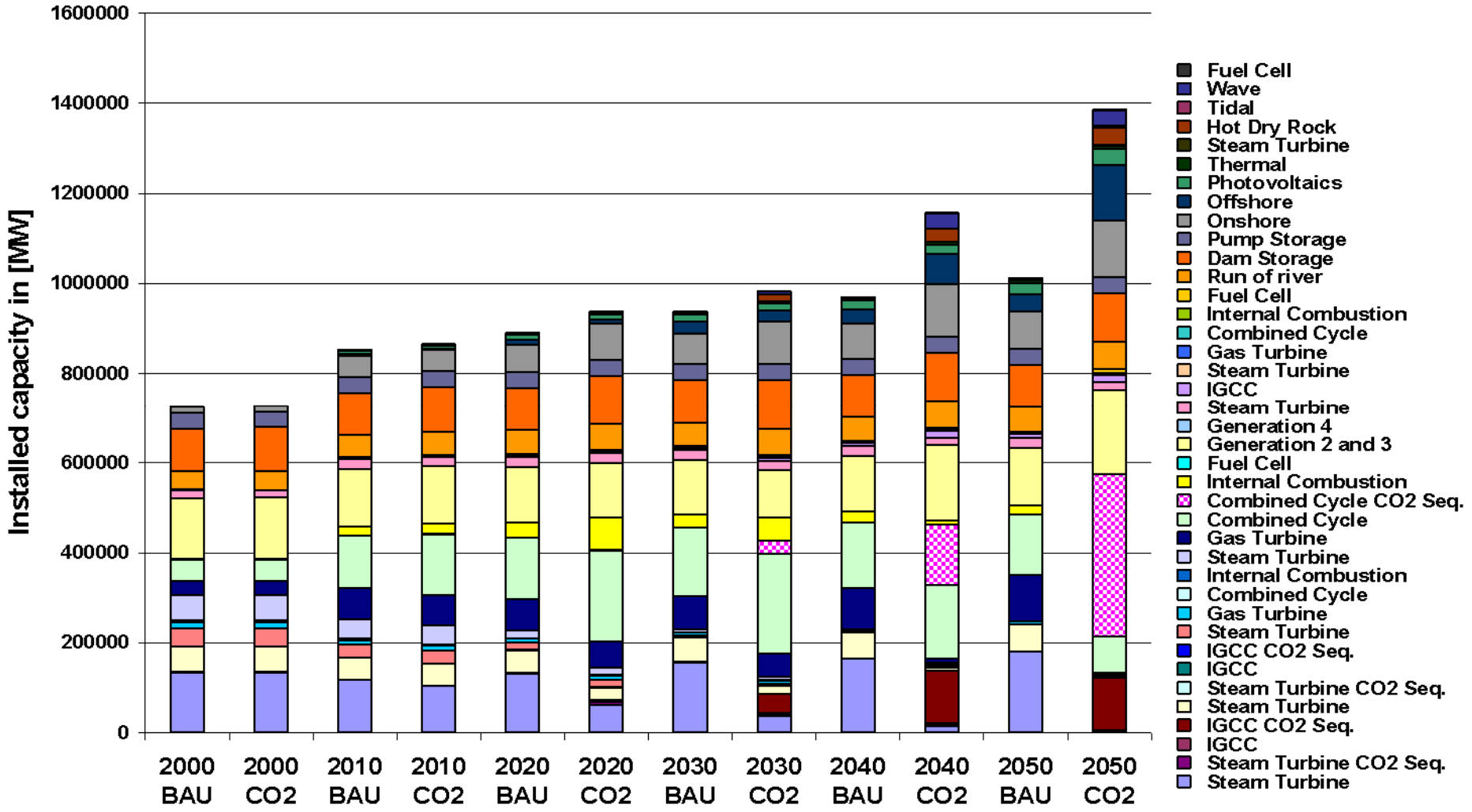


Risø DTU
National Laboratory for Sustainable Energy

Fusion in the energy systems – starting point

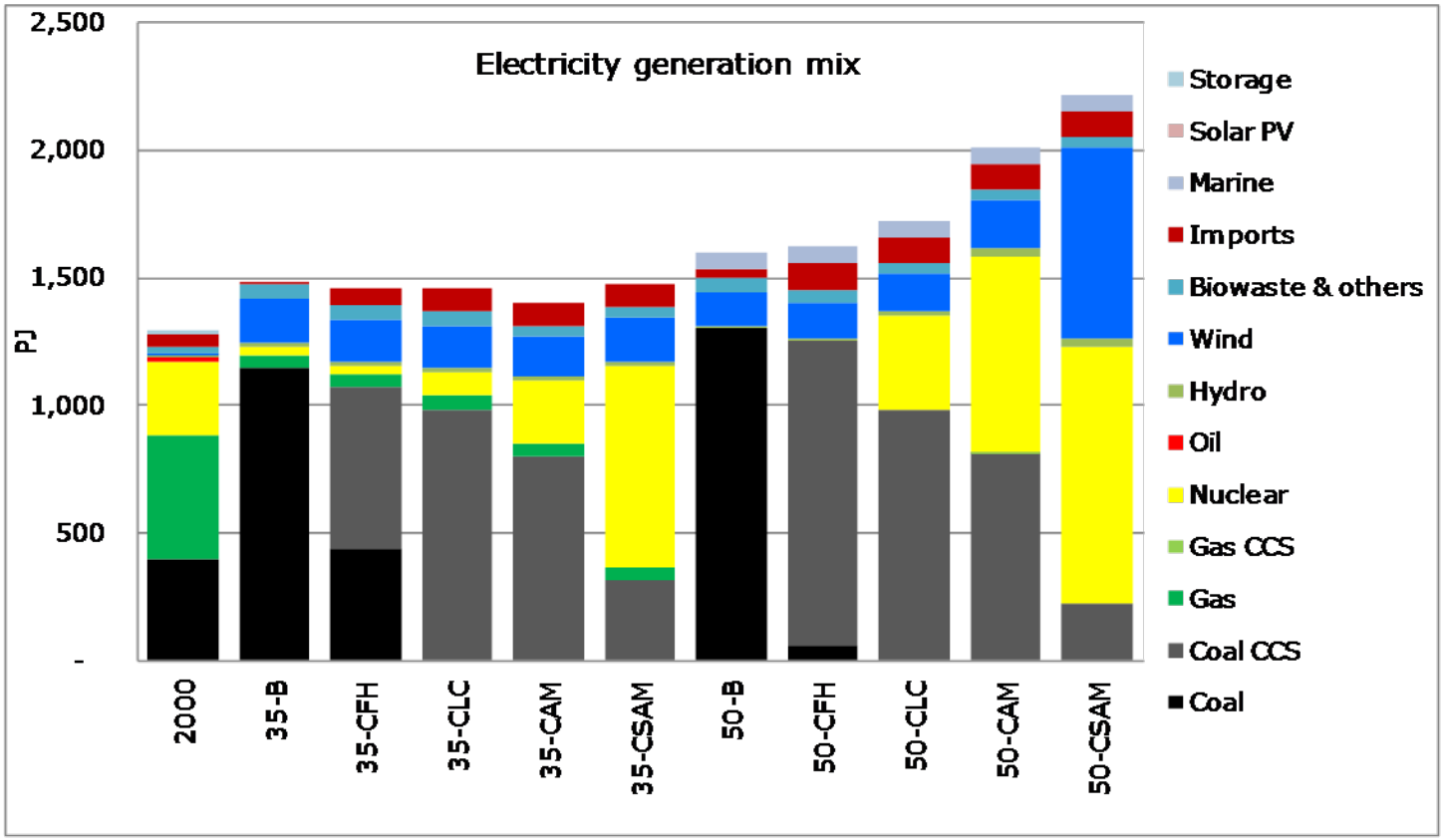
- Unit size 1.5 GW, similar to fission units or 2-3 large coal units
- Very large base-load units
- Steam parameters 600-800 ºC, similar to advanced coal or combined cycle gas turbines
- Suitable for large-scale combined heat and power (CHP) for urban district heating
- Suitable for catalytic hydrogen generation
- Available from 2050 onwards

NEEDS-TIMES – Results of Pan European Model



Source: Markus Blesl, IER Stuttgart. NEEDS Project. Results Oct. 2007, CEEH Workshop Risø DTU Feb. 2008

UK 2050: Decarbonisation of Power Sector (CO2 reduction 40-90 %)



- Power sector is decarbonised by three technologies/resources
- Small cost differential between Coal-CCS, Nuclear and Wind
- Rising electricity production – linkages to buildings and transport sectors

Source: Dr. Neil Strachan, King's College London, FENCO 'Storage Utsira' Kick-Off meeting 10-02-09

Flow optimisation models

Variables:

Flows

Capacity investments

Objective function - options:

Min. total system costs

Max. contribution margin/utility

Constraints:

Demands

Commodity balances

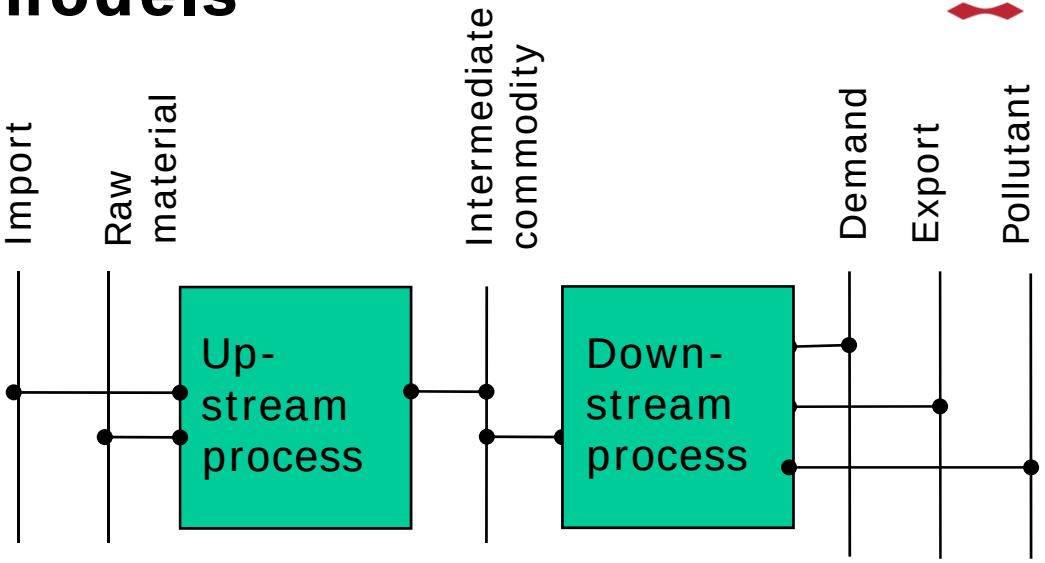
Flow-capacity

Non-negative variables

Multi-period options

Myopic - period by period

Full foresight -
Discounted objective function



Basic parameters:

Initial capacities

Efficiencies

Prices

Optional parameters:

Price elasticities

Emission factors

Discount rate

Model systems:

Excel solver

EFOM

MESSAGE

MARKAL/TIMES

Balmorel

EFDA-TIMES: Long-term optimisation focusing on fusion

- Global energy model in 15 regions
- Network on energy demand and supply
- Time horizon 2100
- First version 2005
- Current study under Socio-Economic Research on Fusion (SERF)
- Results focusing on technologies for electricity generation
- Fusion: Starts 2050, small share to 2070. Significant contribution by 2100.
- Will replace mainly large capital-intensive technologies, in particular fission.

Fusion in the energy systems – annotated references

The NEEDS-TIMES Pan European model was developed as a part of a large Integrated Project – 66 participants, 54 months –under the EU 6th Framework Programme, "NEEDS - New Energy Externalities Developments for Sustainability", Research Stream 2a "Modelling internalisation strategies, including scenario building.", www.needs-project.org

The scenarios for UK 2050: "Decarbonisation of Power Sector" are calculated by UK MARKAL, which was developed by several research teams under the UK Energy Research Centre, to be used for the Government's Energy White Paper 2007 and later. www.ukerc.ac.uk

The EFDA-TIMES global model is developed under the European Fusion Development Agreement (EFDA) Socio-Economic Research on Fusion (SERF), www.efda.org

The model generators MARKAL and TIMES are developed since 1976 by the IEA Implementing Agreement Energy Technology Systems Analysis Programme (ETSAP), www.etsap.org

Further details:

Poul Erik Grohnheit, Using the IEA ETSAP modelling tools for Denmark, Risø-R-1656(EN), www.risoe.dtu.dk/Knowledge_base/publications/Reports/ris-r-1656.aspx?sc_lang=en